

DOCUMENT RESUME

ED 448 199

TM 032 229

AUTHOR Collins, Kathleer M.; Onwuegbuzie, Anthony J.
TITLE Relationship between Critical Thinking and Performance in Research Methodology Courses.
PUB DATE 2000-11-15
NOTE 24p.; Paper presented at the Annual Meeting of the Mid-South Educational Research Association (28th, Bowling Green, KY, November 17-19, 2000).
PUB TYPE Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Academic Achievement; *Critical Thinking; Educational Research; *Graduate Students; Graduate Study; Higher Education; *Methods Courses; *Performance Factors; *Research Methodology

ABSTRACT

This study assessed the relationship between students' ability to interpret and to apply research methodology and their critical thinking skills. Participants were 103 graduate students from various disciplines, enrolled in 6 sections of an introductory level educational research course at a southeastern university. These students were administered the California Critical Thinking Skills Test (CCTST), a multiple-choice test that targets core critical thinking skills regarded to be essential elements in a college education. Conceptual knowledge, which involved students' knowledge of research concepts, methodologies, and applications, was measured via comprehensive written midterm and final examinations. Findings revealed moderate statistically significant relationships between overall critical thinking skills and the midterm ($r=0.34$, $p<0.001$) and final ($r=0.26$, $p<0.01$) examination scores. In addition, canonical correlation analyses indicated that both achievement scores were related to analysis, evaluation, and inference CCTST subscales. (Contains 3 tables and 36 references.) (Author/SLD)

Running head: RELATIONSHIP BETWEEN CRITICAL THINKING

ED 448 199

Relationship Between Critical Thinking and Performance in Research Methodology Courses

Kathleen M. Collins

Saint Mary's University

Anthony J. Onwuegbuzie

Valdosta State University

PERMISSION TO REPRODUCE AND
DISSEMINATE THIS MATERIAL HAS
BEEN GRANTED BY

A.J.
Onwuegbuzie

IN THE EDUCATIONAL RESOURCES
INFORMATION CENTER (ERIC)

1

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

- ☒ This document has been reproduced as received from the person or organization originating it.
- ☐ Minor changes have been made to improve reproduction quality.
- Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

TM032229

Paper presented at the annual meeting of the Mid-South Educational Research Association,
Lexington, Kentucky, November 15, 2000.

BEST COPY AVAILABLE

Abstract

This study assessed the relationship between students' ability to interpret and to apply research methodology and their critical thinking skills. Participants were 103 graduate students from various disciplines, enrolled in six sections of an introductory-level educational research course at a southeastern university. These students were administered the California Critical Thinking Skills Test (CCTST), a multiple-choice test that targets core critical thinking skills regarded to be essential elements in a college education. Conceptual knowledge, which involved students' knowledge of research concepts, methodologies, and applications, was measured via comprehensive written midterm and final examinations.

Findings revealed moderate statistically significant relationships between overall critical thinking skills and the midterm ($r = .34, p < .001$) and final ($r = .26, p < .01$) examination scores. Additionally, canonical correlation analyses indicated that both achievement scores were related to analysis, evaluation, and inference CCTST subscales ($R_c = .35, p < .05$).

Relationship Between Critical Thinking and Performance in Research Methodology Courses

According to the American Philosophical Association (1990), critical thinking is the process of purposeful, self-regulated judgement. Moreover, this construct is the cognitive engine which promotes problem-solving and decision-making. Central to critical thinking are the cognitive skills of interpretation, analysis, evaluation, inference, and explanation. As noted by Facione, Facione, Blohm, Howard, and Giancarlo (1998), these cognitive skills are utilized interactively in the reflective reasoning process that involves formulating a decision and solving a problem. In particular, while engaged in this process, an individual not only attempts to determine in a selective manner what to believe and what actions to take, but the person also possesses the capacity to apply appropriately the core critical thinking skills (Facione et al., 1998).

As noted by Facione et al. (1998), people who possess critical thinking skills are apt to provide reasoned consideration to context, evidence, theories, procedures, and criteria in order to form a purposeful judgement. Thus, an important goal of higher education is to promote and to foster critical thinking skills (McBride & Reed, 1998). In particular, the National Institute of Education (1984) recommended that university-level curricula provide for "the development of capacities of analysis, problem solving, communication, and synthesis" (p. 43). Similarly, the Association of American Colleges (1985) advocated strongly that students learn inquiry skills, critical analytical skills, abstract logical thinking skills, and the like. Indeed, many of these skills have been identified as important in interpreting and applying research methodology at the graduate level (Onwuegbuzie, 1997). For example, a common skill that is emphasized by instructors of research methodology courses is the

ability to evaluate published research articles in their fields utilizing principles of the scientific method (Wilson & Onwuegbuzie, 1999).

As conceptualized by Burns and Grove (1987), critiquing a research article involves at least five stages. The first stage involves identifying the study's elements, as well as understanding the nature, significance, and meaning of both implicit and explicit components. This stage could be categorized as the analytical component of critical thinking. The second step of article critiques necessitates the interpretation of the nomenclatures, philosophies, theories, and concepts utilized in the report in a manner consistent with the researcher(s). This phase is consistent with the interpretational aspect of critical thinking. With respect to the third stage, it is essential that students have extensive knowledge of what each step of the research process comprises in order to assess the extent to which the article follows this process. This level is compatible with the evaluational skills associated with critical thinking. In the fourth step, it is necessary that students are able to identify the expressed and unexpressed assumptions of the researcher, as well as to examine the theoretical aspects of the study. Further, students must be aware of the links between the elements of the study, as well as relationships between components of the study and extant research. The explanation component of critical thinking is the hallmark of this stage. Finally, conceptual clustering (Werley & Fitzpatrick, 1985) must be undertaken, which maximizes the meaning attached to research findings, highlights gaps in the knowledge base, and generates new research questions. This stage is consistent primarily with the inferential aspect of critical thinking, as well as with the interpretational, analytical, evaluational, and expository stages. Thus, each of these five stages of the article critique

process appears to utilize one or more components of critical thinking.

The current assessment reform movement in research methodology and statistics courses encourages instructors to think more broadly about cognitive measures which assess student learning (Garfield, 1994; Lesh & Lamon, 1992; Romberg, 1992). In response, instructors of these classes have begun incorporating innovative methods of assessment into their courses, one of the most common of these being authentic assessment (Onwuegbuzie, 2000). Authentic assessment is a method of collecting information concerning students' understanding in contexts which reflect *real-life* situations, and which challenge students to apply what they have learned in their courses in authentic settings (Archbald & Newmann, 1988). In an attempt to incorporate authentic assessment into their courses, an increasing number of research methodology instructors are assigning their students research projects, whereby students conduct action research studies, in which real data are collected, analyzed, and interpreted.

According to Schwartz, Slate, and Onwuegbuzie (1999), action research involves an eight-step cyclical process, as follows: (a) identifying an issue or problem to investigate; (b) gathering and reviewing relevant literature; (c) formulating research questions and/or hypotheses; (d) developing a research plan of action; (e) implementing the research plan; (f) analyzing the data and interpreting the findings; (g) communicating the findings; and (h) repeating the cycle with a modified problem or strategy derived from what was learned in the previous cycle (i.e., problem redefinition), until the research question is addressed in its entirety. As is the case for article critiques, these eight phases each appear to involve at least one of the cognitive skills associated with critical thinking (i.e., interpretation, analysis,

inference, evaluation, and explanation).

Interestingly, several researchers have reported a significant relationship between critical thinking skills and disposition and various indices of academic aptitude and performance. For example, using the Watson-Glaser Critical Thinking Appraisal (Watson & Glaser, 1980), Behrens (1996) found that scores on the critical thinking test was a better predictor of nursing education performance, as measured by grade point average, than was prior high school grade point average or class ranking. Similarly, the CCTST has been found to be positively associated with scores on the verbal and mathematics portions of the Scholastic Achievement Test and on the ACT, with correlations ranging from .40 to .55 (Facione et al., 1998). Also, Facione et al. (1998) reported a significant relationship between CCTST scores and college grade point average, as well as scores on the Nelson-Denny Reading Test (Brown, Fishco, & Hanna, 1993). At the graduate level, the CCTST has been found to be significantly related to scores on the verbal, quantitative, and analytic portions of the Graduate Record Examination (GRE), as well as to GRE total scores, with correlations ranging from .58 to .72.

However, there is limited empirical evidence assessing the degree that critical thinking skills influence student performance in research methodology courses. Thus, the purpose of the present investigation was to assess the relationship between students' achievement in research methodology courses, as measured by their ability to understand the research process, and their critical thinking skills. It was hypothesized that students who demonstrate the highest critical thinking skills also would attain the highest level of overall performance in research methodology courses.

Method

Participants

Participants were 103 graduate students from various disciplines, enrolled in six sections of an introductory-level educational research course at a southeastern university. The same instructor taught all sections of the course. Of the sample, 88.3% were female. The proportion of female students in these sections was typical of the proportion of females enrolled in graduate programs in the College of Education at the time in which the study took place. All participants were enrolled in master's degree programs. The ages of the participants ranged from 22 to 51 ($M = 28.3$, $SD = 7.5$).

Instruments and Procedure

Students were administered the California Critical Thinking Skills Test (CCTST; Facione, 1990a, 1990d, 1992) on the first day of class before any lecturing had begun. The CCTST is a 34-item, 4-option multiple-choice test that targets core critical thinking skills regarded to be essential elements in a college education. Moreover, the CCTST has been used effectively with graduate and professional school students (Facione et al., 1998). High scores on the scale (total = 34) indicates high critical thinking skills. The length of time necessary to administer the CCTST is 45 minutes.

The CCTST was developed following a 46-member American Philosophical Association's Delphi consensus conceptualization of critical thinking (American Philosophical Association [APA], 1990). This instrument yields six scores: an overall score of one's critical thinking skills and five subscale scores. The five subscales are analysis, evaluation, inference, deductive reasoning, and inductive reasoning. The first three CCTST subscales

(i.e., analysis, evaluation, inference) encapsulate the major core skills identified in the theory of critical thinking advanced in the Delphi Report (APA, 1990). These were the three subscales that were used in the present investigation.

Analysis includes the sub-skills of categorization, clarifying meaning, examining ideas and identifying and analyzing arguments. *Interpretation* represents assessing claims and contentions, querying evidence, conjecturing alternatives, and drawing conclusions. *Evaluation* includes the sub-skills of stating results, justifying procedures, and presenting arguments. Each of the 34 items on the CCTST represents one of these three subscales. Interestingly, the CCTST is considered to be the best commercially-available instrument measuring critical thinking skills (Facione, 1990a). Scores from the 1989-1990 validation study of the CCTST yielded classical theory alpha reliability coefficients ranging from .68 to .70 (Facione, 1990c). For the current inquiry, scores pertaining to the CCTST had a classical theory alpha reliability coefficient of .72.

Conceptual knowledge, which involved students' knowledge of research concepts, methodologies, and applications, was measured via comprehensive written midterm and final examinations. These examinations consisted of open-ended questions, involving items that required knowledge of the research process. All of the items on the midterm examination form pertained to content from the first half of the course and were chosen from the instructor's item bank to ensure that the examination was typical of past examinations given by the instructor. The final examination also was developed by the course instructor and paralleled the format of the midterm examination, yet covered the complete course content. Both the midterm and the final examination were administered under untimed

conditions and were scored on a 100-point scale by the instructor, using a key that specified the number of points awarded for both correct and partial-credit answers.

Results

The means and standard deviations pertaining to the full CCTST scale and the analysis, evaluation, and inference subscales are presented in Table 1. These means were compared to the means reported by the developers of the CCTST (Facione, 1990b). The graduate normative group used in Facione's (1990b) study involved 153 nursing students working toward their Master's degrees in a nationally-ranked nursing program in an urban community. Interestingly, the mean CCTST score reported by the graduate students in the present study (i.e., 16.21) was statistically significantly lower ($t = -4.76, p < .0001$) than that computed for participants in Facione's (1990b) inquiry ($M = 19.01, SD = 5.09$). The effect size associated with this difference was moderate to large. Thus, the graduate students in the current study had a lower propensity for critical thinking skills than did the induction sample. Additionally, a median percentile rank equivalent score (MPRES) was calculated by comparing the median score for the full CCTST scale in the present study to the percentile rank norms reported by Facione (1990b) for the graduate nursing students. The calculated MPRES of 32 for the full CCTST scale indicates that at least 50% of the present sample scored higher than did 32% of the normative group. Thus, it is clear that the participants in the current investigation represented a cohort of students who had low overall critical-thinking scores.

Insert Table 1 about here

The Shapiro-Wilk test (Shapiro & Wilk, 1965; Shapiro, Wilk, & Chen, 1968) did not indicate that the distribution of overall CCTST scores ($W = .99, p > .05$) was non-normal. Similarly, the distribution of the midterm ($W = .98, p > .05$) and final ($W = .99, p > .05$) examination scores did not appear to depart from normality. Thus, the use of correlational analyses appeared to be justified. Pearson's product-moment correlation coefficients, using the Bonferroni adjustment, revealed moderate statistically significant relationships between overall critical thinking skills and the midterm ($r = .34, p < .001$) and final ($r = .26, p < .01$) examination scores. Specifically, students with the highest scores on the CCTST tended also to attain the highest achievement scores in the research methodology class at both the midpoint and at the end of the course. Table 2 presents the correlation matrix involving the three CCTST subscales and the two achievement measures from which the canonical correlation analysis was undertaken. Because the purpose of the study was to examine the canonical correlation model assumed to underlie these correlations, the correlation matrix was not interpreted.

Insert Table 2 about here

The strength of the relationship between the two sets of variables was assessed by examining the magnitude of the canonical correlation coefficients. These coefficients

represented the degree of relationship between the weighted dimension variables and the weighted achievement variables. In addition, the significance of the canonical roots was tested via the F-statistic based on Rao's approximation (Rao, 1952).

The canonical analysis revealed that both canonical correlations combined were statistically significant ($F [6, 188] = 2.18, p < .05$). However, when the first canonical root was excluded, the remaining canonical root was not statistically significant. Together, these results suggest that the first canonical function was statistically significant, but the second canonical root was not statistically significant. However, because the calculated probabilities are sensitive to sample size, particular attention should be paid to the educational (practical) significance of the obtained results (Thompson, 1980). The educational significance of canonical correlations typically are assessed by examining their size (Thompson, 1980, 1984, 1988, 1990). The canonical correlation indicates how much variance the sets of weighted original variables share with each other (Thompson, 1988). In the present study, the first canonical correlation ($R_{c1} = .35$) appeared to be moderately educationally significant, contributing 12.2% (i.e., R_{c1}^2) to the shared variance. However, the second canonical correlation ($R_{c2} = .07$) did not appear to be educationally significant. Consequently, only the first canonical correlation was interpreted.

Data pertaining to the first canonical root are presented in Table 3. This table provides both standardized function coefficients and structure coefficients. An examination of the standardized canonical function coefficients revealed that, using a cutoff correlation of 0.3 recommended by Lambert and Durand (1975) as an acceptable minimum loading value, all three dimensions of the CCTST (i.e., analysis, evaluation, and inference) made

an important contribution to the achievement composite--with evaluation being slightly the major contributor. With respect to the achievement set, both the midterm and final examination scores made an important contribution to the composite set, with the midterm scores making by far the largest contribution.

Insert Table 3 about here

The structure coefficients (Table 3) similarly revealed that all three CCTST dimensions made important contributions to the first canonical variate. The square of the structure coefficient (Table 2) indicated that evaluation and inference made large contributions, explaining 61.8% and 51.3% of the variance, respectively. Analysis made a moderate contribution. With regard to the achievement cluster, both the midterm and final examination made noteworthy contributions, with the midterm scores making an extremely large contribution--explaining 93.1% of the variance.

Discussion

The purpose of the current study was to determine the relationship between academic achievement in a research method course and critical thinking skills. Interestingly, assuming that the CCTST generates reliable and valid scores that are indicative of critical thinking skills, students in the current investigation tended to demonstrate less adequate critical thinking skills than did the inductive sample of graduate nursing students. However, this result is not surprising, bearing in mind that the issue of critical thinking skills and disposition has been a major focus in nursing education and research (Facione, Facione,

& Sanchez, 1994). Indeed, as noted by Facione and Facione (1996), the conceptual definition of critical thinking has particular application to the nursing field. For example, the cognitive skills of interpretation, analysis, evaluation, inference, and explanation that permeate critical thinking skills and dispositions are necessary for making clinical decisions in the nursing context. Moreover, critical thinking in the field of nursing implies both knowledge-based and clinical judgment skills, which are both essential components of nursing (Delk, 1999).

The major findings were (a) a moderate statistically significant relationship between overall critical thinking skills and both the midterm and final examination scores; and (b) both achievement scores simultaneously were related to the analysis, evaluation, and inference components of critical thinking. This result is consistent with the bulk of the literature that has reported a significant relationship between critical thinking skills and disposition and various measures of academic performance (Behrens, 1996; Facione et al., 1998).

Unfortunately, due to the correlational design used, the causal nature of the relationship between critical thinking skills and research methodology achievement is not clear. For example, the univariate and multivariate relationships found may indicate that critical thinking skills tend to increase performance levels in research methodology courses. This causal direction may occur because critical thinking skills such as interpretation, analysis, evaluation, inference, and explanation also are important skills utilized when conducting article critiques and research studies, as well as when attempting to understand research concepts and methodologies.

However, the fact that the CCTST was administered on the first day of class before

any lecturing begun, does not necessarily mean that any causal relationship between critical thinking skills and research methodology achievement is uni-directional, with the former being the antecedent, mediator, or cause. In fact, it is likely that the relationship between these two constructs is bi-directional. For example, as students improve their critical thinking skills, their ability to understand the research process increases, as manifested by tasks such as being able to read, to understand, to synthesize, to evaluate, and to apply research articles in their fields. At the same time, as these same students improve their research skills, their critical thinking skills further improve, which subsequently enhance their research competency, and so on, until both critical thinking skills and research skills are maximized.

The possibility of a bi-directional relationship between these two variables should be the subject of future studies. In particular, researchers could replicate Maynard's (1996) longitudinal inquiry. Maynard (1996) examined the development of critical thinking skills from the beginning nursing student to the experienced professional nurse, as well as the relationship of critical thinking ability to professional competence over time. Interestingly, Maynard (1996) utilized Benner's (1984) stages of skill acquisition (i.e., novice, advanced beginner, competent, proficient, and expert) as the theoretical framework. Maynard found that critical thinking skills increase significantly as the nurse practiced in the profession. Additionally, critical thinking skills were related significantly to nurses' professional competence. Thus, researchers in the future should (a) compare students with different levels of expertise in research, and (b) study the critical thinking abilities of students as they progress from their first research methodology course (i.e., novice researcher), to the completion of their second or third research course (i.e., advanced beginner), to the

completion of their doctoral degrees (i.e., competent researcher), to the publication of their first few research articles (i.e., proficient researcher), and to the publication of several large-scale studies (i.e., expert). Also of interest is to compare levels of critical thinking skills between researchers who predominantly or exclusively utilize quantitative research methodologies and qualitative researchers. Such investigations will increase our understanding of critical thinking, as it impacts teaching and learning in the context of research methodology courses.

References

American Philosophical Association. (1990). *Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction, (The Delphi Report)*. (ERIC Document Reproduction No. ED 315 423)

Archbald, D., & Newmann, F. (1988). *Beyond standardized testing: Assessing authentic academic achievement in the secondary school*. Reston, VA: National Association of Secondary School Principals.

Association of American Colleges. (1985). *Integrity in the college curriculum: A report to the academic community*. Washington, DC.

Behrens, P. (1996). The Watson-Glaser Critical Thinking Appraisal and academic performance of diploma school students. *Journal of Nursing Education*, 35, 34-36.

Benner, P. (1984). *From novice to expert: Excellence and power in clinical nursing practice*. Menlo Park, CA: Addison-Wesley.

Brown, J.I., Fishco, V.V., & Hanna, G. (1993). *Nelson-Denny Reading Test*. Itasca, IL: The Riverside Publishing Company.

Burns, N., & Grove, S.K. (1987). *The practice of nursing research: Conduct, critique and utilization*. Philadelphia, PA: Saunders.

Delk, S.J. (1999). *Critical thinking skills, dispositions, and academic achievement among associate degree nursing students*. Unpublished manuscript, Valdosta State University, Valdosta, Georgia.

Facione, P. A. (1990a). *Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction*. Millbrae, CA: California Academic

Press.

Facione, P. A. (1990b). *Technical report #2: Factors predictive of CT skills*. (ERIC Document Reproduction Service No. ED 327 550)

Facione, P. A. (1990c). Technical report #2. CCTST experimental validation and content validity. (ERIC Document Reproduction No. ED 327 550)

Facione, P. A. (1990d). *The California Critical Thinking Skills Test (CCTST): Form A*. Millbrae, CA: California Academic Press.

Facione, P. A. (1992). *The California Critical Thinking Skills Test (CCTST): Form B*. Millbrae, CA: California Academic Press.

Facione, N.C., & Facione, P.A. (1996). Externalizing the critical thinking in knowledge development and clinical judgment. *Nursing Outlook*, 44, 129-136.

Facione, P.A., Facione, N.C., Blohm, S.W., Howard, K., & Giancarlo, C.A.F. (1998). *The California Critical Thinking Skills Test. Form A and Form B Test Manual*. Millbrae, CA: California Academic Press.

Facione, P.A., Facione, N.C., & Sanchez, C.A. (1994). Critical thinking disposition as a measure of competent clinical judgment: The development of the California Critical Thinking Disposition Inventory. *Journal of Nursing Education*, 33, 345-350.

Garfield, J.B. (1994). Beyond testing and grading: Using an assessment to improve student learning. *Journal of Statistics Education* [On-line serial], 2(1). Available E-mail: archive@jse.stat.ncsu.edu. Message: send jse/v2n1/garfield.

Lambert, Z.V. & Durand, R.M. (1975). Some precautions in using canonical analysis. *Journal of Market Research*, XII, 468-475.

Lesh, R., & Lamon, S. (1992). *Assessment of authentic performance in school mathematics*. Washington, DC: AAAS.

Maynard, C.A. (1996). Relationship of critical thinking ability to professional nursing competence. *Journal of Nursing Education*, 35, 12-18.

McBride, R.E., & Reed, J. (1998). Thinking and college athletes: Are they predisposed to critical thinking? *College Student Journal*, 32, 443-450.

National Institute of Education. (1984). *Involvement in learning: Realizing the potential of American higher education*. Washington, DC: U.S. Government Printing Office.

Onwuegbuzie, A.J. (1997). Writing a research proposal: The role of library anxiety, statistics anxiety, and composition anxiety. *Library and Information Science Research*, 19, 5-33.

Onwuegbuzie, A.J. (2000). Attitudes toward statistics assessments. *Assessment & Evaluation in Higher Education*, 25(4), 325-343.

Rao, C.R. (1952). *Advanced statistical methods in biometric research*. New York: Wiley.

Romberg, T. (Ed.) (1992). *Mathematics assessment and evaluation: Imperatives for mathematics education*. Albany, New York: State University of New York Press.

Schwartz, R., Slate, J., & Onwuegbuzie, A.J. (1999). Empowering teachers: acting upon action research. *GATEways to Teacher Education*, 11(2), 44-59.

Shapiro, S.S., & Wilk, M.B. (1965). An analysis of variance test, for normality and complete samples. *Biometrika*, 52, 592-611.

Shapiro, S.S., Wilk, M.B., & Chen, H.J. (1968). A comparative study of various tests

for normality. *Journal of the American Statistical Association*, 63, 1343-1372.

Thompson, B. (1980, April). *Canonical correlation: Recent extensions for modelling educational processes*. Paper presented at the annual meeting of the American Educational Research Association, Boston, MA.

Thompson, B. (1984). *Canonical correlation analysis: Uses and interpretations*. Newbury Park, CA: Sage Publications. (ERIC Document Reproduction Service No. ED 199 269)

Thompson, B. (1988, April). *Canonical correlation analysis: An explanation with comments on correct practice*. Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA. (ERIC Document Reproduction Service No. ED 295 957)

Thompson, B. (1990, April). *Variable importance in multiple regression and canonical correlation*. Paper presented at the annual meeting of the American Educational Research Association, Boston, MA. (ERIC Document Reproduction Service No. ED 317 615)

Watson, G., & Glaser, E. (1980). *Critical thinking appraisal manual*. New York: Harcourt, Brace, & Jovanovich.

Werley, H.H., & Fitzpatrick, J.J. (1985). *Annual review of nursing research* (Vol 3). New York: Springer Publishing Company.

Wilson, V., & Onwuegbuzie, A.J. (1999, November). *Improving achievement and student satisfaction through criteria-based evaluation: Checklists and rubrics in educational research courses*. Paper presented at the annual conference of the Mid-South Educational Research Association, Point Clear, AL. (ERIC Document Reproduction Service No. ED 436

569)

Table 1

Means, Standard Deviations, and Medians Pertaining to Scores on the CCTST Scale and Subscale Scores

<i>Measure</i>	<i>M</i>	<i>SD</i>	<i>Median</i>
CCTST Total Score	16.21	3.79	16
Analysis	4.42	1.43	5
Evaluation	5.83	2.27	6
Inference	5.97	1.67	6

Table 2

Intercorrelations Among all CCTST Subscales and Achievement Measures

Theme	1	2	3	4
1. Analysis				
2. Evaluation	.18			
3. Inferences	.08	.37		
4. Midterm	.20	.26	.24	
5. Final	.12	.23	.22	.62

* statistically significant after the Bonferroni adjustment

Table 3

Canonical Solution for First Function: Relationship Between Achievement Scores and Scores on Three Subscales of the California Critical Thinking Skills Tests

Variable	Standardized Coefficient	Structure Coefficient	Structure ²
<i>Critical Thinking Dimension:</i>			
Analysis	.421*	.544*	.296
Evaluation	.538*	.786*	.618
Inference	.486*	.716*	.513
<i>Achievement:</i>			
Midterm examination	.761*	.965*	.931
Final examination	.332*	.802*	.643

* loadings with effect sizes larger than .3 (Lambert & Durand, 1975)